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The Importance of Design Process in Housing Quality

N. Hamzah[a*], A. Ramly[c], H. Salleh[c], N. M. Tawil[b], M. A. Khoiry[a], A. I. Che Ani[b]

[a]*Department of Civil & Structural,*
[b] *Department of Architecture*
Faculty of Engineering and Built Environment
The National University of Malaysia, Bangi, 43600 MALAYSIA

Faculty of Built Environment, University of Malaya, 51000 Malaysia

Abstract

In Malaysia, housing construction industry is moving towards quality.Many construction companies have implemented several Quality Management System (QMS) for instance ISO 9001 and TQM in managing projects to ensure the quality of products. However, aspect of quality in newly built housing are remains an issue. Thus, a survey had been conducted among three construction professionals comprising: private clients, consultants and contractors. ReHDe framework is finally formed with a list of 3 major construct factors and 14 possible variables for managing the quality of house are determined. Results show that by having a good project management practices in place, there will be a significant effect in reducing numbers of defects in housing sector. Design process has appeared to be one of the most important factors that contributing in housing quality. 4 sub factors namely constructability, drawing accuracy, variation and knowledge transfer have been identified and discussed in detail in this paper.

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Keywords: design process; housing quality; commitment to quality and consultant

1. Introduction

Housing is a basic need for all [1] and the good quality of design need to be ensure for the satisfaction of homebuyer. This document is to discuss the the importance of design proses in determining the level

*Corresponding author. Tel.: +60389216219; fax: +60389216841.
E-mail address: ain@eng.ukm.my.

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of housing quality. Housing provision and quality housing are two issues, which remained the subject of research and interest to researchers' and designers'. Whenever a designer completes the project, they are not fully aware of consequences of their design [2]

At design stage, clients' involvement is needed to verify and to contribute necessary input to ensure the project is in the right track and to avoid variation. Variations can cause from client, standards or codes and changes in government regulations and laws. Therefore well planning documentation might help progress of work runs smoothly. It also works to optimise project resources and minimise surprises by getting the plan out early and allow corrective feedback.

In 2003, Andi and Takayuki Minato from Japan found the relation of design quality and quality of construction product. The result of study shows that the problems of defective designs are complex and deep rooted, influenced by many factors operating at individual designer, company, construction industry and global and national levels [3]. Poor performances of project were considered as a direct result of design documents deficiencies [4]. Andi found insufficient design time and fee for design work are the two key factors affecting design document quality. He also noted that design consructability also occurred as problem due to lack of construction knowledge on the designer side need to be given an attention. The latter study on the aspect of design quality stated that the better understanding of client's need may help designer to produce a design to satisfy client as well as standard without neglecting the importance of design constructability [5].

Because of drawings act as communication medium between clients to consultant and between consultant to contractor, lack in clarity, accuracy and detailing of design for example cross sections details of structural elements, joints, plumbing and electrical connections may contribute to drawing's misinterpretation that lead to defect. Therefore, drawings and other types of communication must be systematically documented and well organized to make sure the process of information transfer works effectively.

2. Literature Review

A. Design Stage

The importance of the design process was realised that 80% of the construction cost was taken as soon as the design sketch was made. He also discovered that any mistake or omission that was not discovered or settled earlier could lead to serious demand and rework when the construction starts. In addition, the cost for a mistake in design would cost more than a mistake caused by construction because any deviation in design would increase the project cost in terms of repair and rework costs [6] More than 50% of changes in orders are caused by faulty design.

Realising this importance, several researches were made such as in Kuwait by Kartam (2001) that found out faulty design is one of the main factors that contributed to the disturbance of the project's smoothness. The same went for Japan [3]and in Hong Kong [7].

Meanwhile, [8] discovered that majority source of faulty cause began at design stage. Two main factors identified were weak technical specifications and overlooking of several specific requirements. This finding supported a research carried out by[9] which listed out the cause of defects which are design, specification, law, coordination, communication, supervision and constructability. There are some recommendations from publications which claim that defects cannot be avoided in construction products because of low attention towards quality in the design stage [10]. This happens due to the designer team's initial interpretation towards the clients' idea and the use of drawing as the main communication medium between project players.

According to the multiplex pathway made by Sommerville[10], it shows clearly that the cause and factors of defect are related but the relativity of each cause and factor's importance and strength are still unclear [10]. From the same study, the most important design issue are drawing comprehension, constructability, specification anomalies and ambiguities caused by change and weak understanding towards construction laws, supervision aspects such as misinterpretation of drawings and specifications, usage of superseded drawings and specifications and weak communication between architects, engineers, subcontractors and suppliers [11].

Taking into account the latest study by [12], they recognised32 most significant and critical factors in determining the quality of design. But this study is too wide compared to Chow & Ng's [5] study which oversees eight criterias that can measure a consultant's performance such as shows in the Table 1.

1) TABLE I
CPE CRITERIA AND CORRESPONDING QUANTITATIVE INDICATORS

Criteria at design stage	
DSC1	Compliance and understandings to clients' brief
DSC2	Compliance to legislative requirements
DSC3	Identification of client's requirements & project objectives
DSC4	Quality of design
DSC5	Availability of innovative and alternative solutions
DSC6	Approach to overall cost effectiveness
DSC7	Quality of drawings/ documents
DSC8	Adequacy of cost estimate

Mistakes done during the design stage can be the main source of defects. By taking into account the defect elements as early as the design stage, this can prevent defects from occurring in the final product. The question is, is it practical? For newly completed housing projects, the construction process is normally in a series which refers to the method used to obtain the project, normally open tender method. The conventional method refers to the process where the designer or consultant would complete the design of the house before starting construction. The consultant makes the design based on the client's input and some of his consideration that sometimes results the problem of constructability when the contractor starts the construction.Something needs to be done.

3. Data Collection

A structured survey has been carried out to all over Klang Valley in residential construction sectors. Total respondents gathered for this survey were 416 respondents. Our target respondents were those who involved in construction sector, specified as construction management personnel, who have experience in constructing housing project. Data collected, the highest percentage was Project Manager (23.1%), followed by Project Engineer (22.6%), Consulting Engineer (16.1%), Civil Engineer (13.5%), Others (9,1%), Assistant Resident Engineer (8.2%), and the least Resident Engineer (7.5%). Most of the respondents were comes from various construction affiliation which is developer, contractor, consulting, PMC, sub-contractor and others. Outcomes from the study will be used to develop a housing quality framework for terrace housing unit in Klang Valley from the perspective of these project management personnel. According to repondent's experience, the highest percentage was 5-10 years working

experience (31.3%), followed by 0-4 years (30.8%), more than 15 years (23.8%), and 11-15 years (14.2%). From the percentages, we believe that outcomes from the study can be use to develop a good housing quality framework for terrace housing unit since the percentage among the working experience less or more equally for every working experience sub-interval.

4. Result

From the survey, ReHDe Framework has been established. In design construct, 5 dimension have been identified and displayed as in Figure 1.

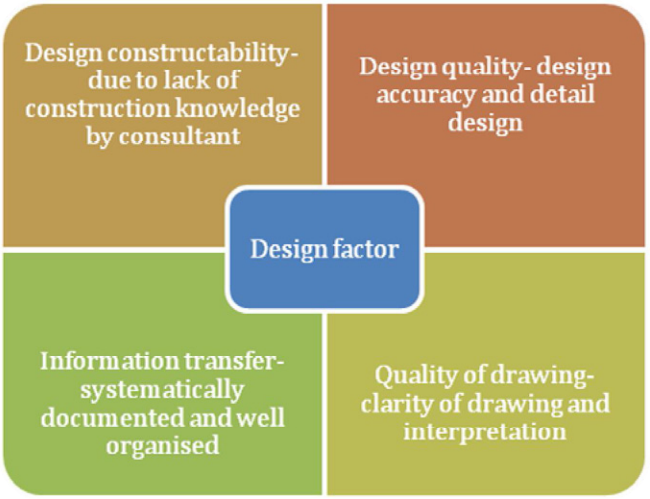

Fig. 1 Design Construct in ReHDe Framework

5. Discussion

Constructability Dimension

The constructability factor may clearly improve quality [13,14] and the construction's productivity [15]. Japan has been known as a country that emphasises on quality. So for them, this problem of design has always been the main agenda to be managed in the construction industry [3]. Research carried out by[3] found out that 44% of the problems arising come from low constructability such as conflicts in structure design, insufficient design for temporary work, unsuitable construction methods and differing site information from the design.

Meanwhile in Singapore, two frameworks have been developed to measure constructability from the quality and productivity aspect. The frameworks are Buildable Design Appraisal System (BDAS). Low (2001) made studies towards all three variables (constructability, quality and productivity). His study managed to prove there was a positive relationship between constructability and construction quality, specifically in structural works. He introduces 3 S as a parameter in measuring constructability which are Standardisation, Simplicity and Single integrated elements.

Other than using the system as a control for the design's constructability quality, the consultant himself is an important component that can make direct changes. It is hard to avoid a consultant that disregards [7] and does not consider the constructability factor [6] in designing. For example, a consultant does not consider a special method in handling a project that has restrictions of site location [6]. It should be his responsibility to minimise the construction procedure when it involves the usage of high and complicated technicalities in design [7].

Like codes, constructability and construction technique also differs with geographical locations. The design should take into account the effectiveness and suitability of the local needs and rechecking should be carried out by a professional consultant. Therefore it is proposed that there should be at least one consultant that has gained teamwork experience on-site to give inputs on the needs of the constructability factor [14]. It would be much better if the designer of the building himself gets involved in the building process [3]. As the designer, he can see for himself what problems arise and make improvement in future designs [3]. In Malaysia, the consultants who are sent to the site are not designers, which make them unfamiliar with the effects of the2D on-paper design towards the real 3D implementation.

Drawing Accuracy and Clarity

An accurate drawing should be free from mistakes and omissions [3]. It also has to be accurate and up-to-date to avoid misinterpretation [5].

Drawings and specifications are documents given by the consultant to the contractor which contains material technical information, the competency of the facility that will be built and the standard of quality supposed to be reached. The drawing will be the only document that shows the design concept, size and scope of work, number and size of material and also the installation method to produce the construction product [14]. Meanwhile, Oberlender[15] claimed that the final product for a design process are a set of contract documents which are drawings and specifications to assist the physical construction of the project. The problem that arises is that discrepancy between drawings and specifications often occur. The quality of a drawing can be measured by clarity, uniformity, detailing and good interpretation into design and free of defects [5].

So, it is critical for the consultant to prepare a clear, precise and uniform drawing because these aspects will influence the quality of the facility to be built [13]. It may also effect coordination of the building process [4]. Not only restricted to drawings and specifications, other supporting documents should also be clear, readable and easy to interpret so that the next process may be carried out smoothly.

Variation

Variation by clients can directly give effects to the planning schedule, design and construction. Variations caused by clients usually have two conditions which are requested by the client or caused by the lack of understanding and knowledge of the project's terms or procedures. For variations caused by the client's demand, they have to take liability especially in terms of cost. Variations caused by the client's lack of knowledge and understanding can be tackled effectively by obtaining an expert's advice or establishing a project group consisting of knowledgable people as soon as possible to help explain the scope and function of the project precisely [15].

Variation may also occur when the consultant makes a mistake in the design. To reduce this problem, the consultant team should really understand the client's needs as well as performing a comprehensive site investigation to obtain reliable information to design and set up an effective communication system among consultant groups [16]. Other than that, by using the approach of Design and Build (D & B), it can also reduce the potential of design or drawing defects occurring by involving consultants from the

beginning stage of the project to harmonise the design process with the site condition and constructability [16]. The question that arises is that how many housing projects use these approaches in their project acquirement? In Malaysia, most of the housing projects use the conventional acquirement method such as shown in the figure below.

The difficulty to get the contractor to give input as early as the design stage will eventually cause the consultant to work alone. In assuring the design will be zero-defect and free of variation in the future, the consultant should be able to think in a comprehensive view, consider the site condition based on available information, consider the constructability factor and also fulfil the client's demands in his design. This is where his competency and experience will be tested.

Knowledge Transfer

Drawings and documentation should be updated and reachable if required. A drawing is seen as a communication medium to coordinate project players in interpreting design [3]. All other drawings and documents should be consistent, precise and comply to the standard requirement and local authority. It should also be able to picture the precise geographical and topographical condition of the site including the utilities and available structures.

By adapting new technology such as 3D CAD (Computer Aided Drafting & Design), robotics and animation in construction, it has increased the interest to produce a more innovative and efficient design. This technology can be used as a track to share and transfer information between contractors and consultants by taking into account crucial factors such as constructability especially before and during design establishment [15].

Besides translating the client's idea into the form of design and drawing, a consultant should also play the role of guiding clients that are not experienced about engineering technicalities. They should listen and try to understand the needs of the client and also explain to the client what could or could not be done according to the procedures and laws. They should also help the client to identify and establish a more relevant objective in terms of engineering perspective. As a consultant that has more technical knowledge compared to the client, the produced design should be more balanced in fulfilling the client's and engineering needs [5]. Overall, it is crucial for the consultant to listen, understand and comply to the client's brief when the client voices out his dream to develop a project [5]. Other than verbal communication between consultant and client, communication between consultant and contractor is also encouraged to increase the design quality. However, this chain is very weak in government projects especially in Japan [3] as well as in Malaysia.

6. Conclusion

The role of the consultant in giving good quality consultation can be achieved in many ways. It started with collecting all the required information to fulfill the need of clients. Then, understanding the information and process in the form of drawings and specifications precisely; and finally the contractor can understand clearly and implements the clients' needs according to drawings and specifications prepared by the consultant [17].

References

[1] Chohan, A.H. , Che-Ani, A.I., Tahir, M.M., Abdullah, N.A.G., Tawil, N.M. and Kamaruzzaman, S.N. *Housing and Analysis of Design Defects: A Post Occupational Evaluation of Private Housing in Malaysia*. International Journal of The Physical Sciences 6(2):193-203 No. ISSN * 1992-1950

[2] Chohan, A.H. , Che-Ani, A.I., Tahir, M.M., Abdullah, N.A.G., Tawil, N.M. and Kamaruzzaman, S.N. *Housing and Analysis of Design Defects: A Post Occupational Evaluation of Private Housing in Malaysia.* International Journal of The Physical Sciences 6(2):193-203 No. ISSN * 1992-1950

[3] Andi and T. Minato, *Design documents quality in the Japanese construction industry: factors influencing and impacts on construction process.* International Journal of Project Management, 2003. 21(7): p. 537-546.

[4] Pheng, L.S. and P. Ke-Wei, *A framework for implementing TQM in construction.* The TQM Magazine, 1996. 8(5): p. 39 - 46.

[5] Chow, L.K. and S.T. Ng, *Expectation of performance levels pertinent to consultant performance evaluation.* International Journal of Project Management, 2007. 25(1): p. 90-103.

[6] James L. Burati, Jr., F.M. Michael, and N.K. Satyanarayana, *Quality Management in Construction Industry.* Journal of Construction Engineering and Management, 1991. 117(2): p. 341-359.

[7] Ahmed, S.M., K.T. Li, and D.D. De Saram. *Implementing and Maintaining a Quality Assurance System - A Case Study of a Hong Kong Construction Contractor*. in *Proceedings of the 3rd International Conference, ISO 9000 & Total Quality Management*. 1998. Hong Kong Baptist University, Hong Kong.

[8] Lam Siew Wah, L.C.M.T.W.A., *ISO 9000 in Construction*1994, PTSL,UKM: McGraw Hill Book Co.

[9] Elliott, S.J., S.M. Taylor, and R.A. Kearns, *Housing satisfaction, preference and need among the chronically mentally disabled in Hamilton, Ontario.* Social Science & Medicine, 1990. 30(1): p. 95-102.

[10] Sommerville, J., *Defects and rework in new build: an analysis of the phenomenon and drivers.* Structural Survey, 2007. 25(5): p. 391 - 407.

[11] Chung, H.W., *Understanding Quality Assurance in Construction: A Practical guide to ISO9000*1999, London: E & FN Spon.

[12] Zeng, S.X., P. Tian, and C.M. Tam, *Quality assurance in design organisations: a case study in China.* Managerial Auditing Journal, 2005. **20**(7): p. 679 - 690.

[13]Tam, C.M., et al., *Performance assessment scoring system of public housing construction for quality improvement in Hong Kong.* International Journal of Quality & Reliability Management, 2000. **17**(4/5): p. 467 - 478.

[14]Arditi, D. and H.M. Gunaydin, *Total quality management in the construction process.* International Journal of Project Management, 1997. **15**(4): p. 235-243.

[15] Zou, P.X.W., G. Zhang, and J. Wang, *Understanding the key risks in construction projects in China.* International Journal of Project Management, 2007. **25**(6): p. 601-614.

[16] Amir, H. and H. Samuel, *TQM Training for Small and Medium Industries in Malaysia.* Training for Quality, 1994. **2**(2): p. 27-35.

[17] Harrington, H.J., *Cost of Poor Quality.* International Journal of Strategic Cost Management, 1999(Summer): p. 17-27.